Space Weather Technical Forecast

Issued on Saturday 25 January 2025 at 12:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: A chance of G1-G2 geomagnetic storms this UTC weekend, with a ongoing chance of isolated M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity was at Moderate levels, with peak activity a M2.7 flare at 24/2104UTC from AR3961 in the southwest disk.

There are currently six numbered sunspot regions on the Earth-facing disc, and one small unnumbered region. The largest, most active and nominally most complex region remains AR3961 in the southwestern quadrant. This group has shown a spreading trend and fading in its central and trailing portions, but still a possible weak Mt Wilson delta spot candidate south of the main penumbral leader, giving a Ehi/Beta-Gamma-Delta classification. The other region of potential note is AR3971 in the northwest, which although has now plateaued in areal extent, shows some spot emergence in its Dai/Beta classification. Other regions are relatively small or seemingly stable.

No Earth-directed Coronal Mass Ejections (CMEs) feature in this forecast. A C8.8 flare at 24/1620UTC caused some very minor dimming near central disc, however no clear CME was visible in imagery, with any ejecta likely assumed slow.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1 fell from Slightly Elevated levels, around 450km/s, to current background speeds of around 390 km/s. The solar wind density was below average. The IMF was weak, peaking at 6nT, with the north-south component varying between +5/-4nT. The phi angle was erratic but remained negative (towards the Sun).

The net result of the above solar wind measures was Quiet geomagnetic activity.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 was at background levels.

High energy electron flux (greater than 2MeV) at GOES16 was Moderate, with a diurnal peak of 712pfu seen at 24/1810UTC. The associated 24-hour fluence persisted below the Active threshold, reaching 2.81e7 integrated pfu at 25/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate solar activity expected with a likelihood of isolated M-class flares and a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: Up to two CMEs may affect Earth in the period. The first a 21 January CME, which had a risk of narrowly glancing around 25/0600UTC and may have already missed Earth. The second a potentially fuller glance from a 22 January CME, due 25/1800UTC. No new coronal holes feature in the forecast.

Quiet to Unsettled activity (Kp1-3) is expected in general, but with a chance of Minor to Moderate G1-G2 geomagnetic storms through days 1-2 (25-26 Jan) in association with potential CME arrivals, with a slight chance of Strong G3 geomagnetic storm intervals.

Energetic Particles / Solar Radiation: A slight chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur.

GOES16 high energy electron flux is forecast to see a gradual decline, but with an uncertain impact from any CME arrival. The corresponding 24-hour fluence is currently expected to remain below the Active threshold throughout.

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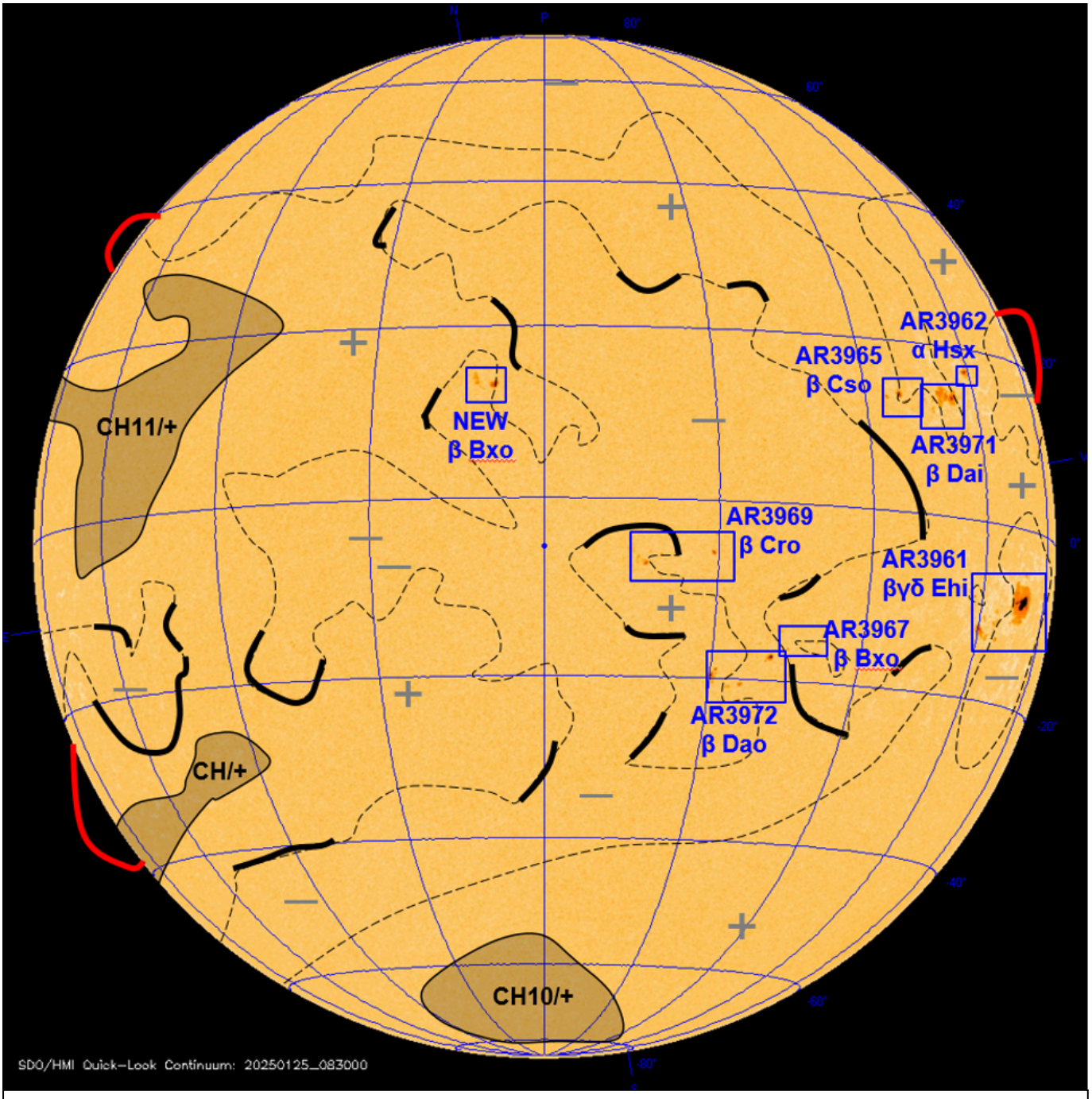
Figure 1: Solar Synoptic Map valid 25/0830UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Currently two CMEs feature in the forecast - firstly that from an M-flare from AR3967 on the 21 January, and secondly a filament and M1.3-flare related event near AR3961 from 22/1108UTC.

Of the CMEs, the first event is of lesser concern, being modelled in MOSWOC ENLIL as a slight glancing blow at 25/0600UTC, which is now considered unlikely to arrive. On its own, this might perhaps present a Slight Chance of G1, however it may be rendered more significant for any priming of the Earth's magnetosphere and cannibalization by the advance of the later, more direct and larger event from the M1.3, expected around 25/1800UTC. This has been re-analysed as presenting a Chance of Moderate/G2 geomagnetic storms into the UTC evening of Saturday 25 January, with a full halo shock but with the dark helicoidal filament emission (in AIA304) perhaps appearing confined to the southern solar hemisphere (i.e. mainly below the Sun-Earth line).

MOSWOC ENLIL keeps the CME impacts as separate events, however there is a small chance that they coincide, which is the reason for the non-zero but not favoured risk of Strong G3. These probabilities then fade through the second half of the weekend (UTC) to leave a Quiet to Unsettled start to the forthcoming new working week.

Quiet to Unsettled activity (Kp1-3) is expected in general, but with a chance of Minor to Moderate G1-G2 geomagnetic storms through days 1-2 (25-26 Jan) in association with potential CME arrival, with a slight chance of Strong G3 geomagnetic storm intervals.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	30	5	5
Strong	G3	No	10	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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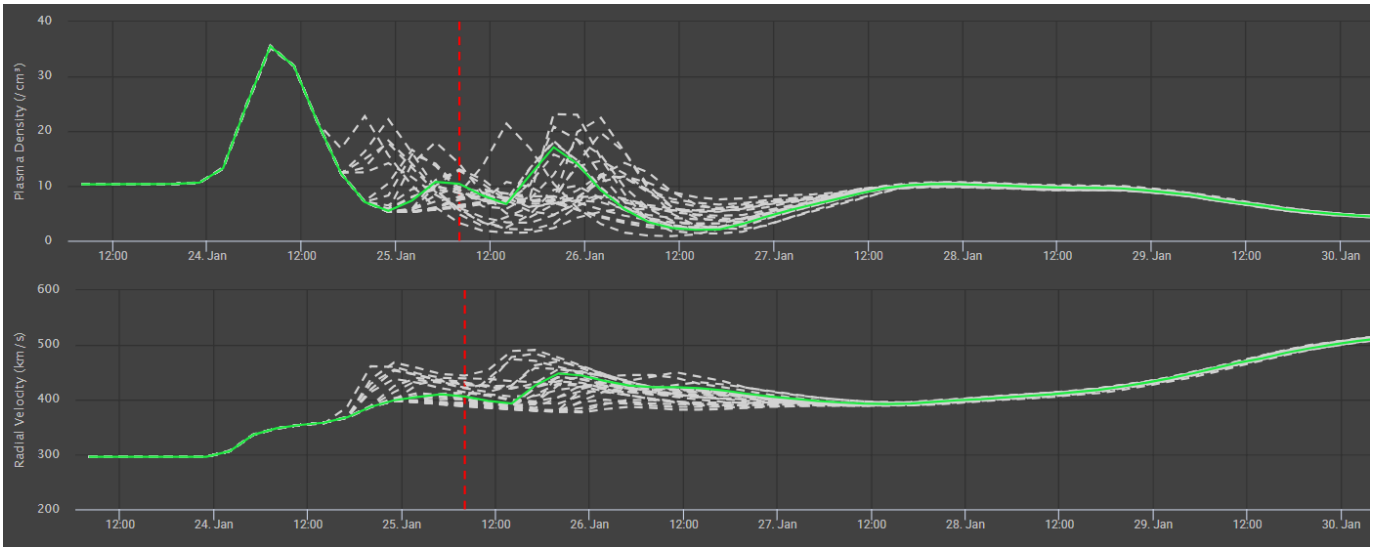
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
21/1027	Partial	AR3967	SE	537	25/0600	Small chance of glance and G1, perhaps primes magnetosphere to increase impacts from later CME. May have already missed Earth.
22/1727	Full	AR3961	S Centre	591	25/1800	Greater chance of glance relative to above, G2 most likely.

Figure 2: Latest MOSWOC ENLIL Ensemble output.



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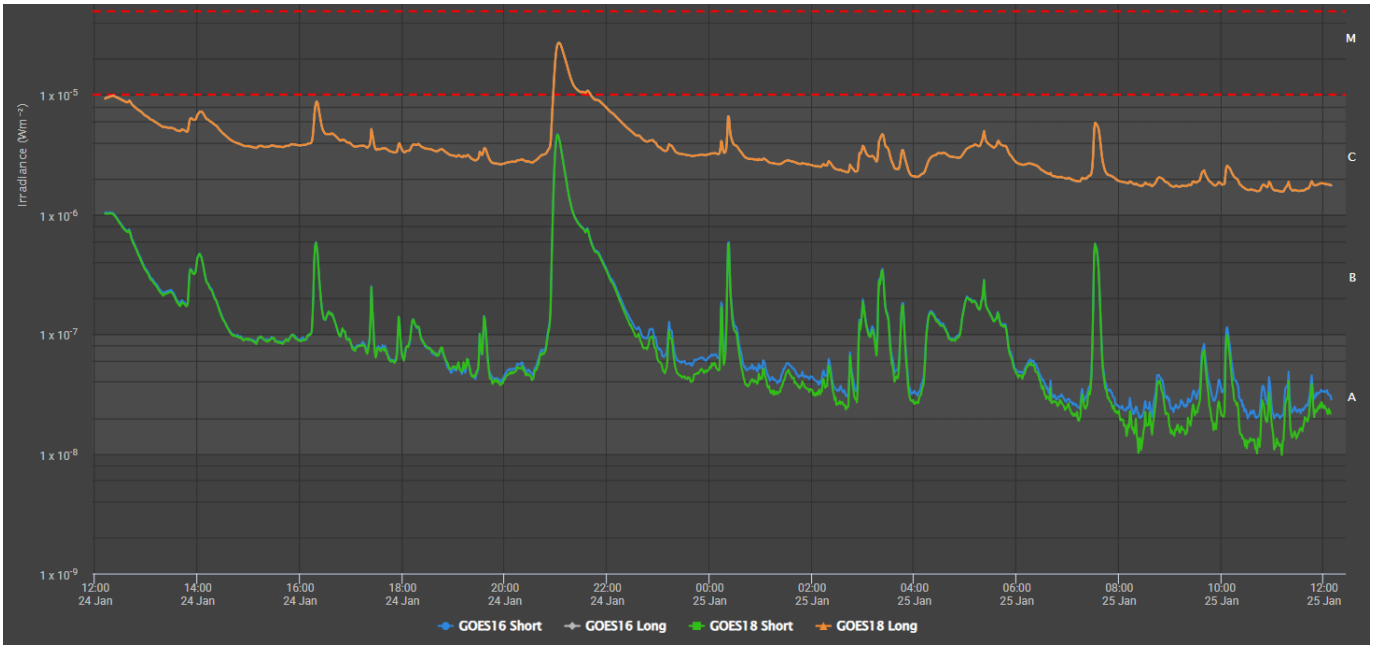
Radio Blackouts - X-Ray Flares

The current Earth-facing disc is showing a westward bias in active region populations, with the far side conversely showing an eastward shift, i.e. diametrically opposite. This means that trends in the coming four-day forecast period will rely on a trade-off between the departure of sunspot regions and any east limb arrivals, with the latter probably the larger factor given a series of CMEs emitted from around the east limb during the UTC day of Thursday 23 January. The current most active group, AR3961, will reach the west limb into day 3 (27 Jan), with recurrence suggesting a similar timeframe for increased activity rounding the east and southeast limb. This evolution supported by helio-seismic data.

Overall, the daily flare risk is kept steady pending further developments. Generally Moderate solar activity expected with a likelihood of isolated M-class flares and a slight chance of isolated X-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 3: 24hr GOES16/18 X-Ray Flux trace.



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Solar Radiation Storms (High Energy Protons)

A Slight Chance of Proton enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur though the period, this risk coming chiefly from AR3961 as it continues to transit towards, and over, the east limb.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has seen recent diurnal peaks of High flux. This has arisen from the declining phase of connection to CH09/-, with this driving feature now lying over the western limb. No further coronal hole enhancements are expected in the forecast period, and in the absence of further inputs a gradual decline in flux levels is tentatively forecast. Potential CME arrival(s) may also produce a rapid decline in flux levels at GEO into the period. However, confidence is low because of the uncertainly around CME arrivals and their geomagnetic impact.

The corresponding 24-hour fluence is expected to remain below the Active threshold, with a gradual downward trend. MOSWOC REFM is felt to be reflecting this idea in the near-term, although it should be should be treated as low confidence given the potential for CME influence.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	5	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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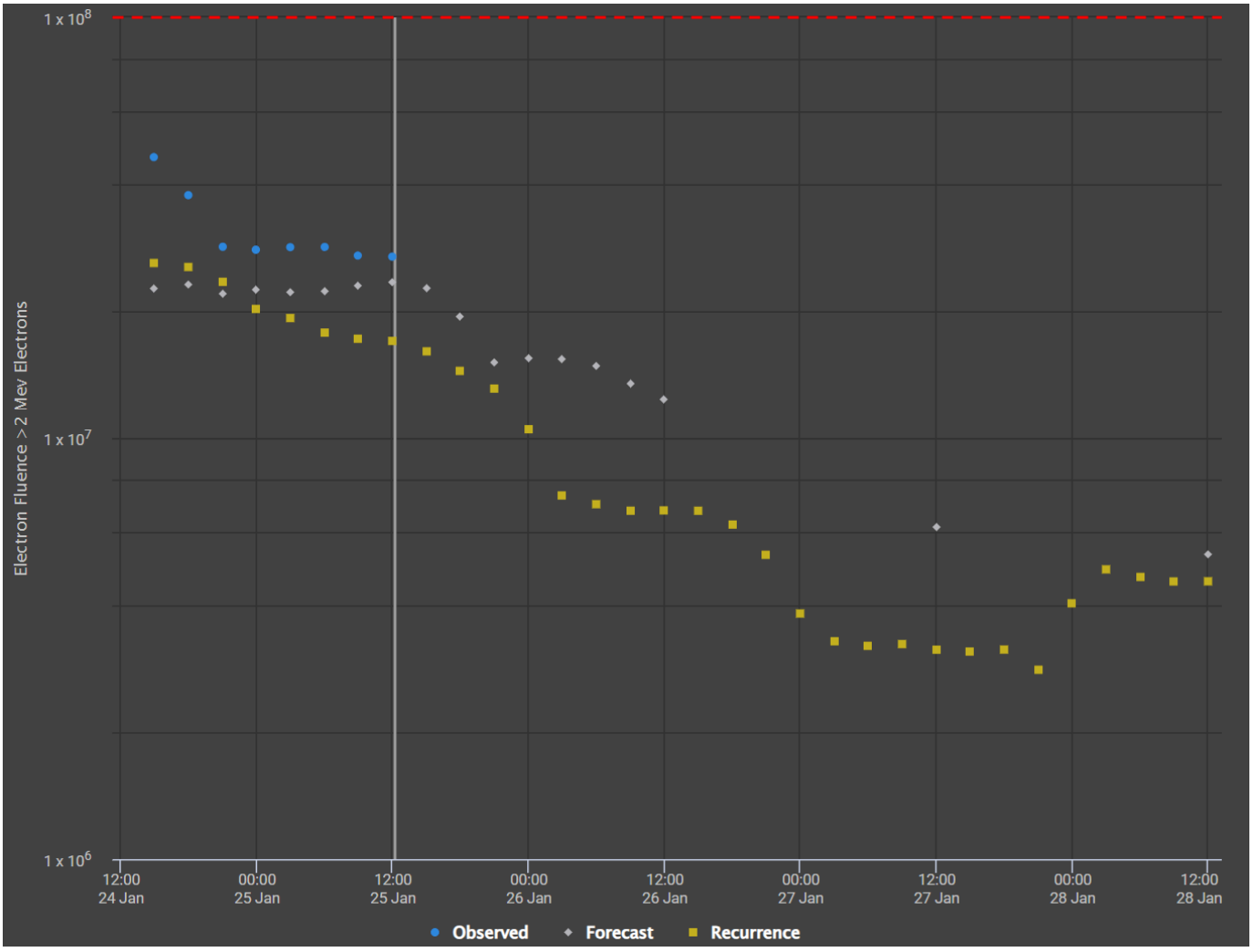
Figure 4: Latest MOSWOC REFM output.



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